test and measurement

# Portable, Low-Cost, Nondestructive Materials Testing

*...for resin-based composites and metal oxides*

NASA Goddard Space Flight Center (GSFC) invites companies to license a new nondestructive method for evaluating degree of cure, variations in chemical composition, and defect states in resin-based composites and metal oxides—data currently unobtainable through X-ray testing. Featuring a novel use of ultraviolet spectroscopy and imaging, this highly portable technique has proven effective at testing materials used in spacecraft thermal protection systems. It can be used on both conductive and nonconductive materials, penetrating to a depth of 200 µm.

## Benefits

- **Nondestructive**: Materials are not damaged or destroyed as a result of the evaluation.
- **Lightweight and highly portable**: The technique is capable of *in situ* measurements, which eliminates the need to disassemble large structures or destructively obtain small samples that are later tested in a laboratory.
- **Cost-effective**: This methodology relies on hardware widely used in ultraviolet imaging and spectroscopy.

technology opportunity

## Applications

- **Aerospace**: Real-time process control of a composite structure's initial curing
- **Composite storage tanks**: Gasoline or chemical storage tank inspection
- **Composite bridges**: Earthquake responsive
- **Dental composites**: End-cure, point-of-composite fillings
- **Material analysis**: Testing composite components

## Technology Details

The method represents a novel application of an existing technique to evaluate the degree of cure, significant changes in chemical structure, and other properties of resin-based composite materials using ultraviolet spectroscopy and imaging. It operates in the reflectance, absorbance, and luminescence modes and may be used to analyze defect states of inorganic materials, such as silicates and metal oxides. The inventor currently is using the method as part of a research and development effort associated with the Crew Exploration Vehicle (CEV) Thermal Protection System Advanced Development Project. In particular, the method is being employed to clarify differences in the thermal degradation of candidate materials for CEV's heat shield.

### *How it works*

Using commercially available ultraviolet light sources (laser, xenon, lamp, or LED-based), the operator illuminates the surface of the composite material being tested. The reflected response is acquired via the imaging system or spectrometer. The operator then analyzes the spectra for the presence of conjugated organics as well as semiconducting band-edge or defects. These spectra are then compared with a database for variations in conjugation and substitution or length of molecule.

### *Why it is better*

Currently, no portable method to test cure states and the chemical composition of resin-based materials exists. Neither ultrasound nor X-ray methods provide information about compositional variations associated with manufacturing or changes over time. While infrared spectroscopy can deliver that type of information, this technique is difficult to use because it can destroy particular types of resins. The ultraviolet imaging and spectroscopy method also is advantageous because it is portable, uses easily obtainable off-the-shelf hardware, and is safe for the operator and the material being tested.

### *Patents*

NASA Goddard Space Flight Center is seeking patent protection for this technology.

### *Partnering Opportunities*

This technology is part of NASA's Innovative Partnerships Program, which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Ultraviolet Spectroscopy and Imaging Technique for Nondestructive Evaluation (GSC-15338-1) for commercial applications.

For information and forms related to the technology licensing and partnering process, please visit the Licensing and Partnering page of the Goddard Innovative Partnerships Program Office's Web site (http://ipp.gsfc.nasa.gov/lic-partnerships.html).

## For More Information

If you are interested in more information about this technology (GSC-15338-1), please contact:

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